Hybrid Wind Stress Anomalies and Their Impacts on the Global HYCOM Simulations ?

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MOTIVATION

- 0.72° Global HYCOM
  - Climatologically–forced simulations
  - ECMWF wind stress anomalies for various periods

- Impact of different anomaly periods on global simulations
  - Sea surface temperature (SST)
  - Mixed layer depth (MLD)
  - For Atlantic only and global ocean:
  - Depth of max. of overturning streamfunction
  - Max. transport of overturning streamfunction

WIND STRESS ANOMALIES

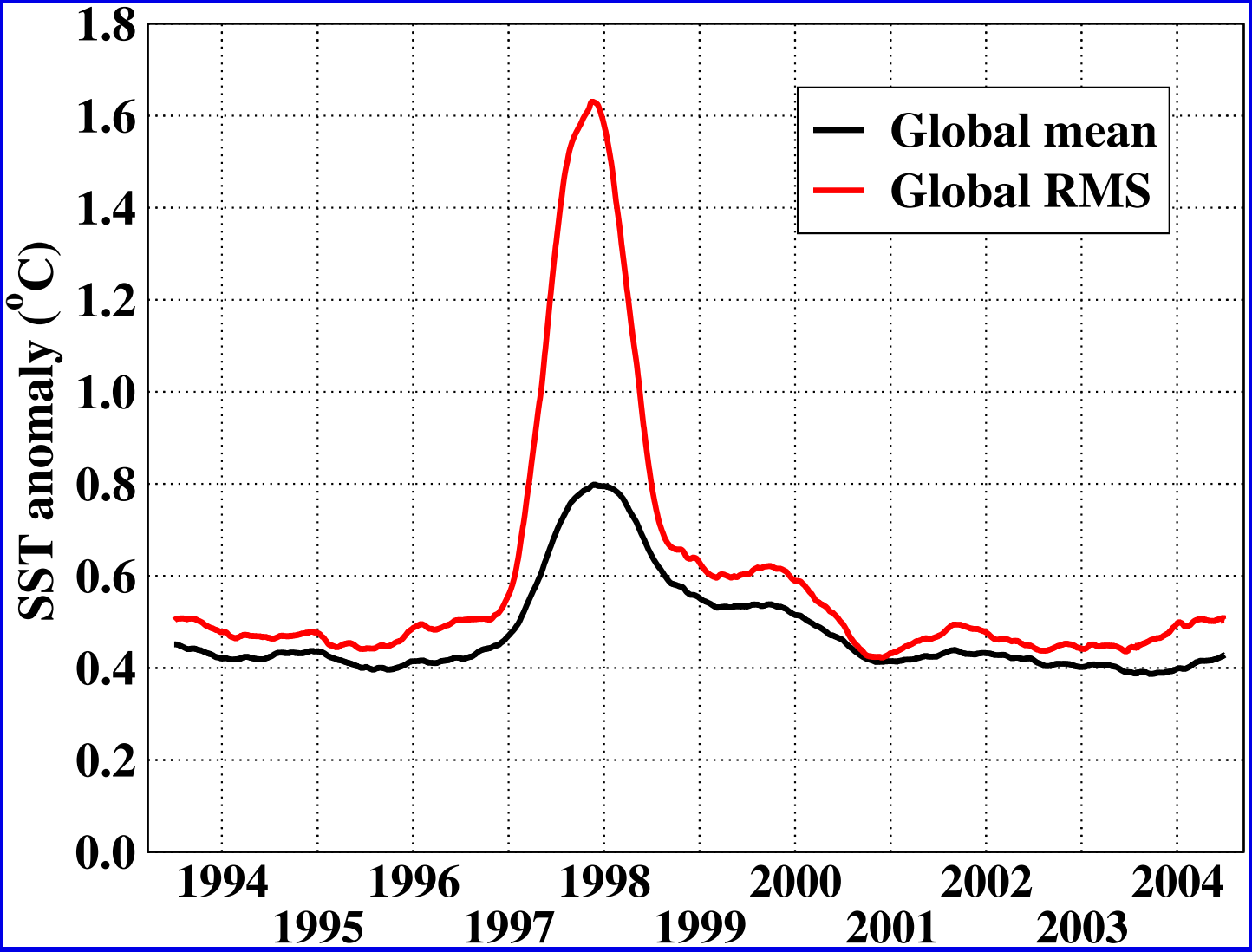
- We would like to use a time period,
- representing a climatological normal year:
- For historical reasons HYCOM used: Sep94–Sep95
- Other candidate time periods
    - Sep95–Sep96
    - Apr97–Apr98
    - Jan98–Jan99
    - Aug00–Aug01
    - Aug01–Aug02

The question is:

Which time interval for wind stress anomalies is appropriate for realistic HYCOM simulations?

First, why did we choose those time periods above?

SST ANOMALY OVER THE GLOBAL OCEAN



- Use daily MODAS SSTs from 1993 through 2004
- Form daily anomalies (Interannual- Climatology)
- Calculate square of anomaly fields
- Apply 1–year running average

Note that we also selected the 1997–98 ENSO period.

A MOVIE FOR WIND ANOMALIES

- Use ECMWF wind stresses
- 6 hourly anomalies added to monthly means
- This is done for each time period
- A movie of wind speed
    - at each 6 hour time intervals

GLOBAL HYCOM DESCRIPTION

- 0.72° fully global model
    - o 0.36° near equator
    - o Arctic bipolar patch
- 26–layer HYBRID
- Initialization: Navy GDEM3 T/S climatology
- Monthly river discharge from NRL database
- Sea surface salinity relaxation to monthly PHC

PHC: Polar science center Hydrographic Climatology

Atmospheric forcing is from ERA–15

- Bulk formulation for sensible and latent heat fluxes
- Shortwave and longwave radiation from ERA–15
- Water turbidity based on SeaWiFS ocean color data

HYCOM SIMULATIONS

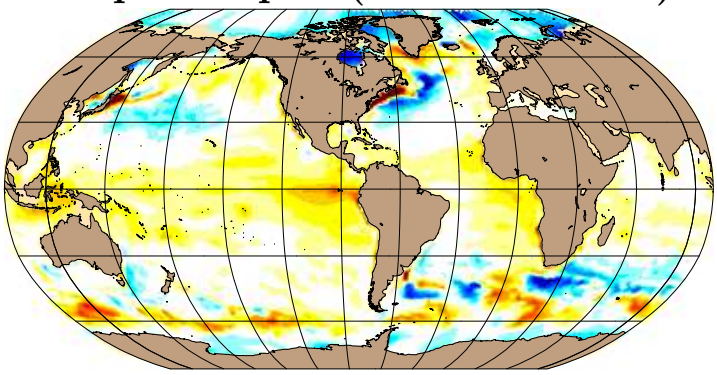
- Use KPP mixed layer model
- Perform climatologically–forced simulations

There is NO data assimilation or relaxation to SST climatology

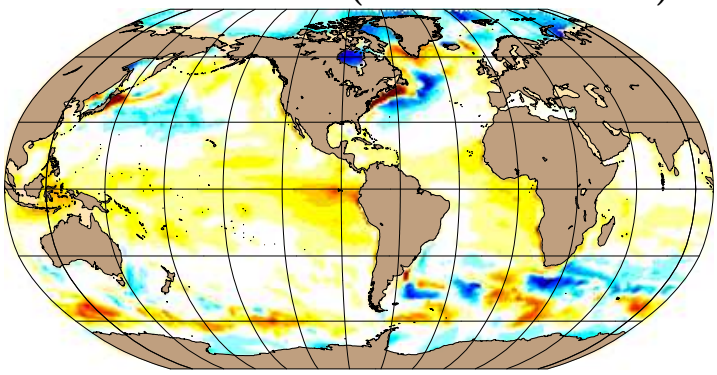
- All simulations are identical except wind anomalies

ANNUAL MEAN HYCOM SST BIAS

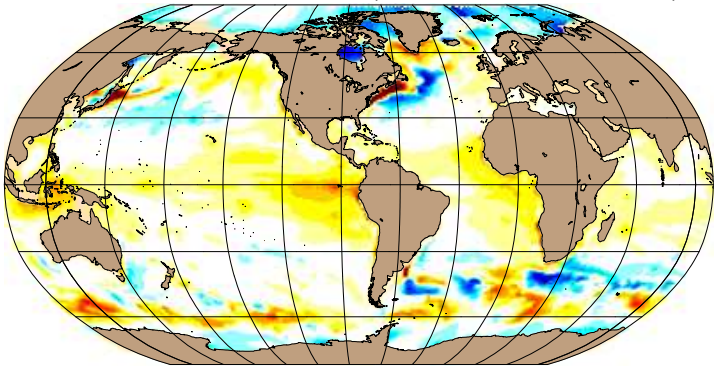
Sep94–Sep95 (BIAS = 0.4°C)



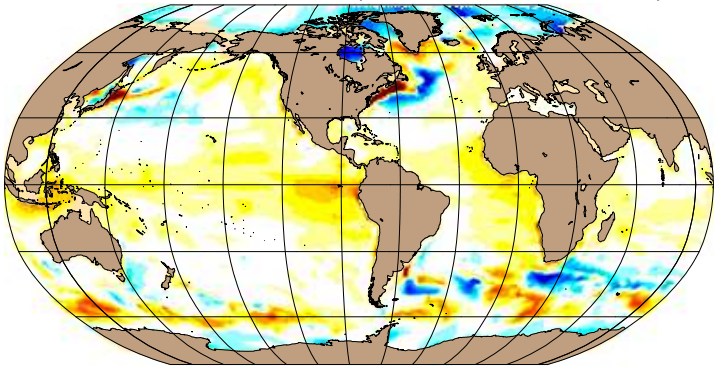
Feb95–Feb96 (BIAS = 0.4°C)



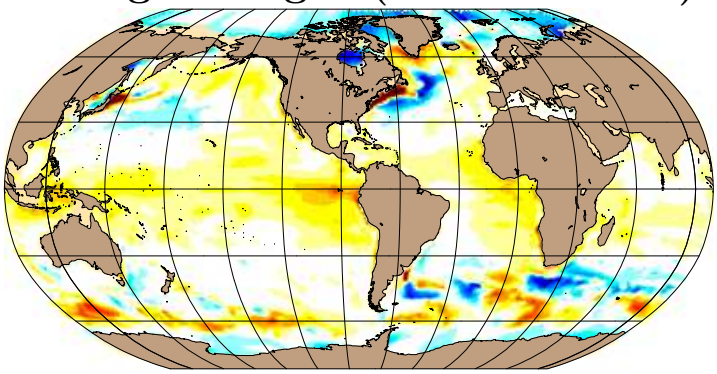
Apr97–Apr98 (BIAS = 0.4°C)



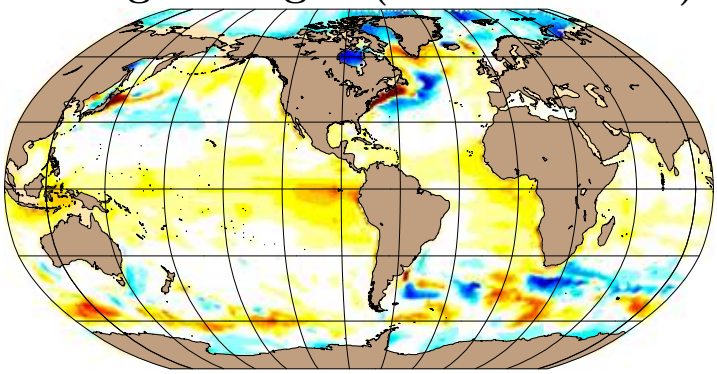
Jan98–Jan99 (BIAS = 0.4°C)

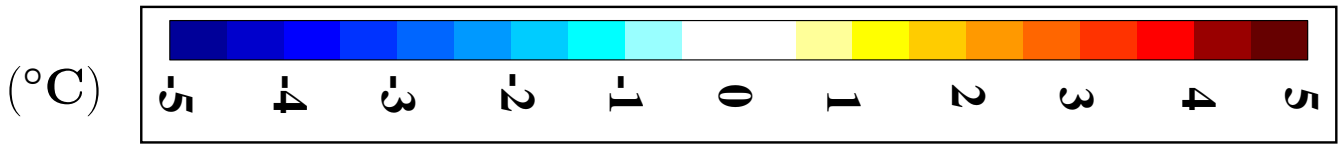


Aug00–Aug01 (BIAS = 0.4°C)



Aug01–Aug02 (BIAS = 0.4°C)

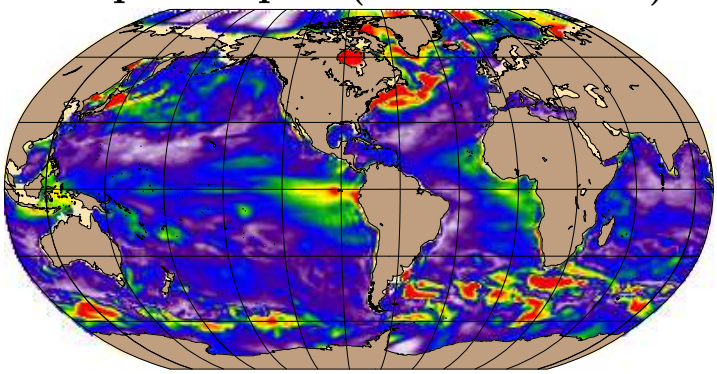




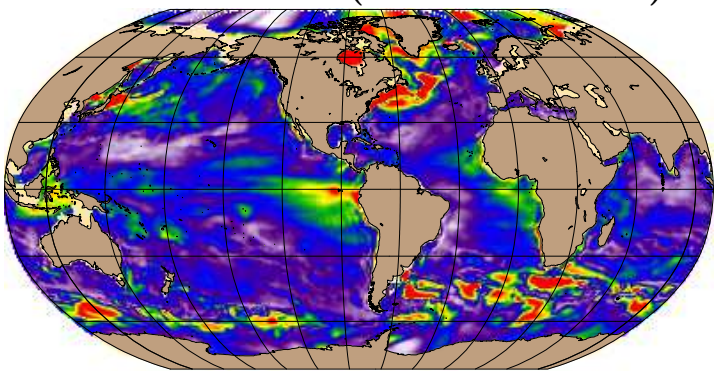
HYCOM bias is with respect to NOAA SST climatology

RMS DIFFERENCE: HYCOM vs NOAA SST

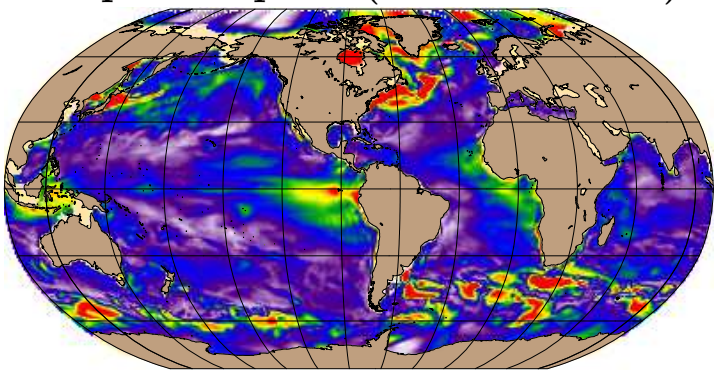
Sep94–Sep95 (RMS = 0.9°C)



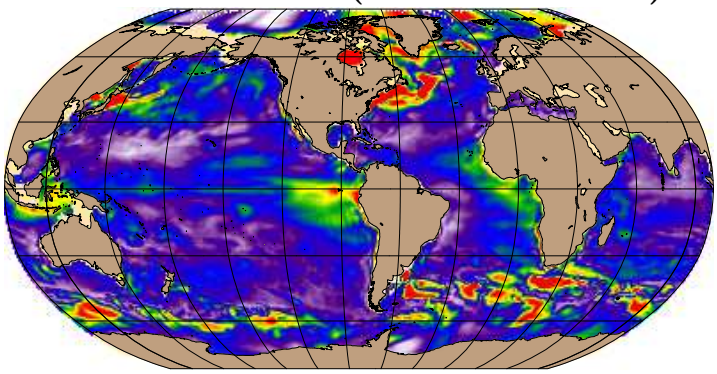
Feb95–Feb96 (RMS = 0.9°C)



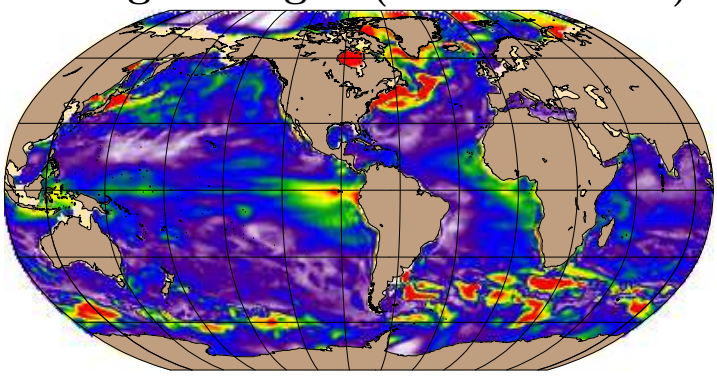
Apr97–Apr98 (RMS = 0.9°C)



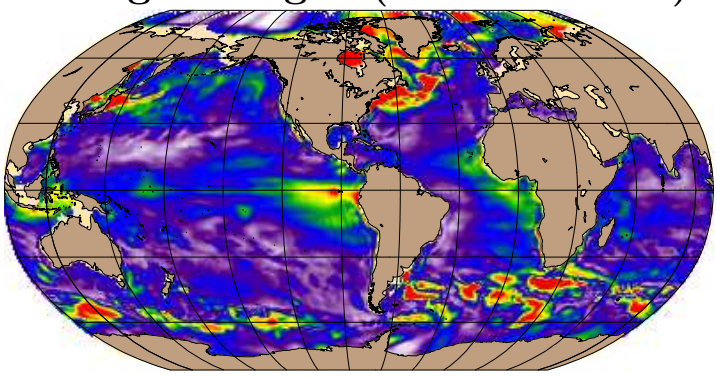
Jan98–Jan99 (RMS = 0.9°C)

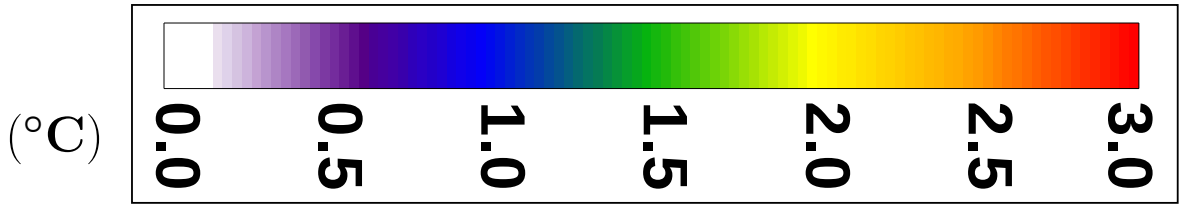


Aug00–Aug01 (RMS = 0.9°C)



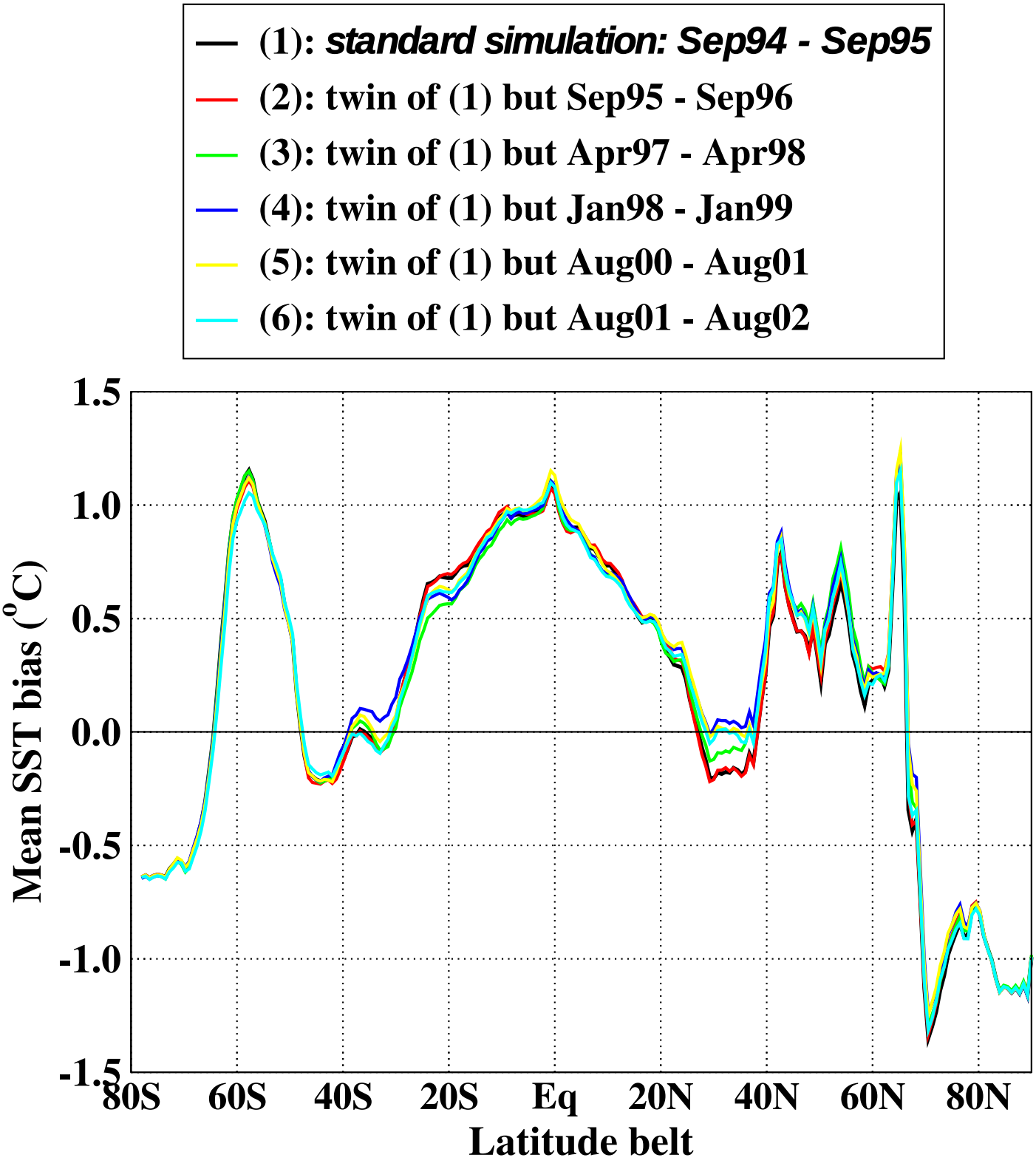
Aug01–Aug02 (RMS = 0.9°C)



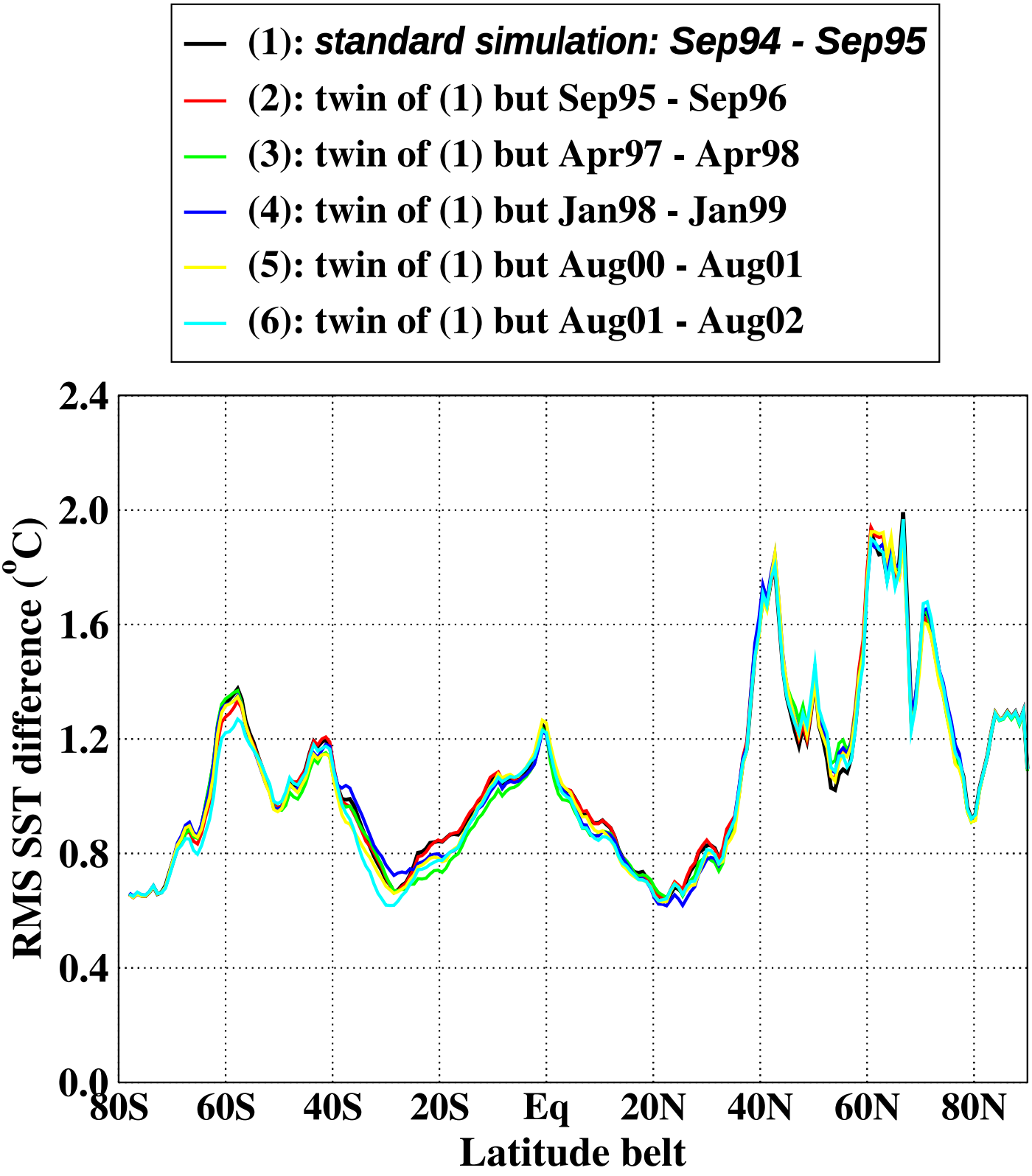


RMS is calculated over the seasonal cycle

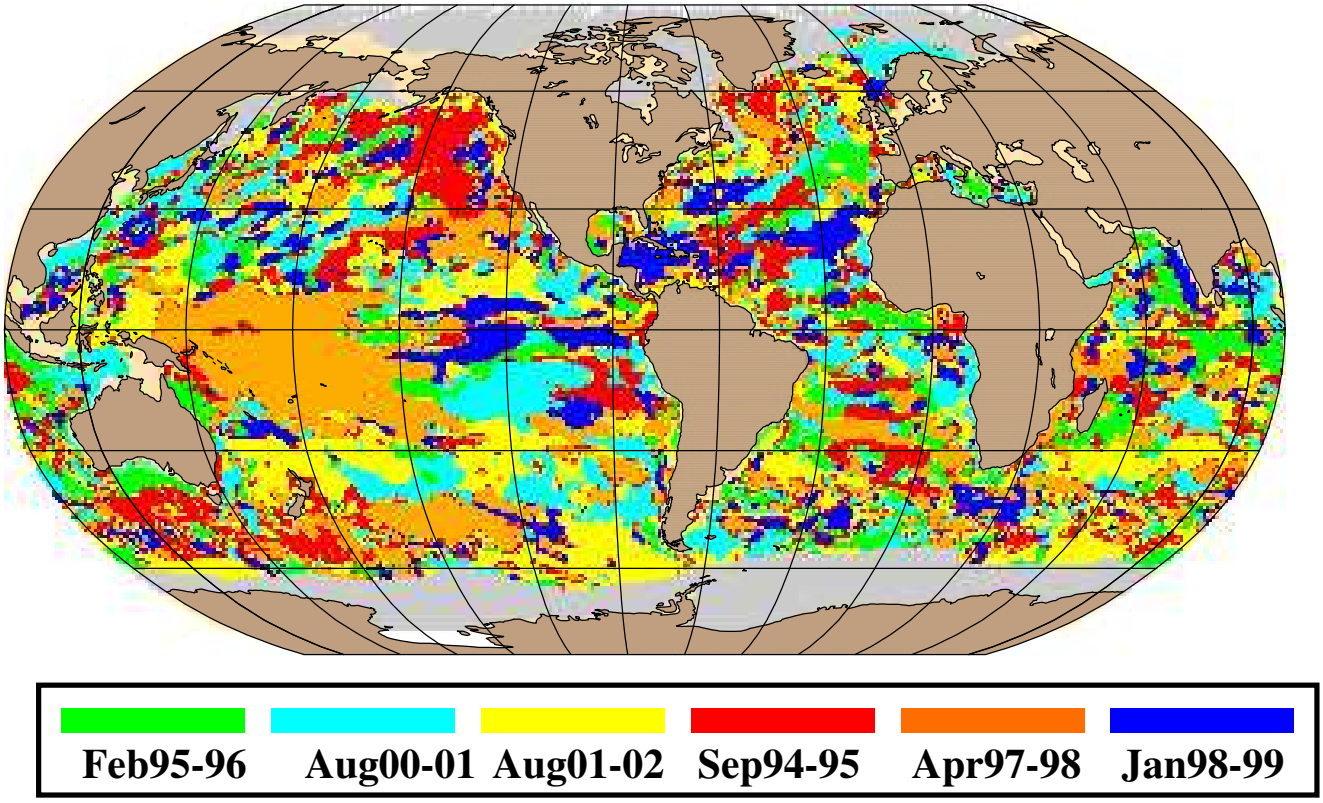
ZONAL AVERAGES FOR SST BIAS



ZONAL AVERAGES FOR RMS DIFFERENCES



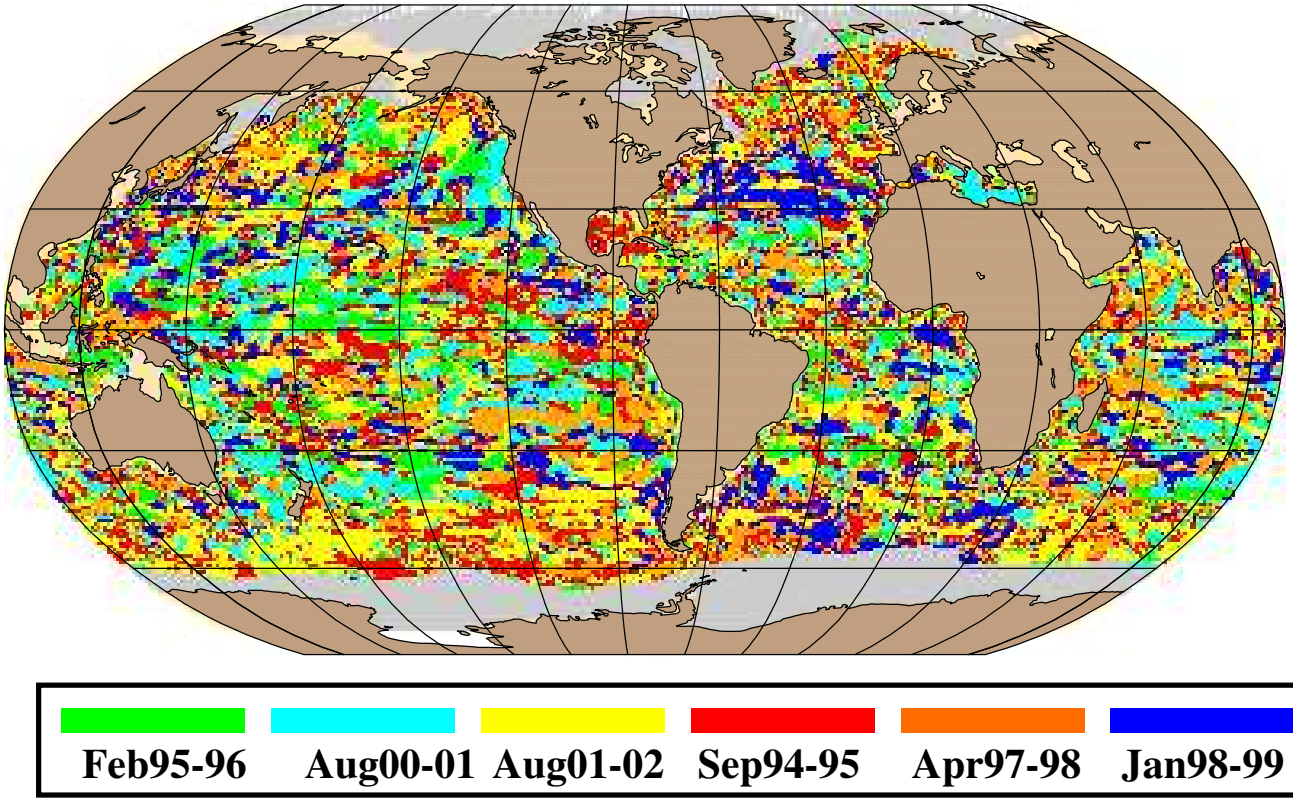
LOWEST RMS SST DIFFERENCES



Percentage of global ocean coverage:

Anomaly	Percentage	Rank
Sep94–95	14.2%	4
Feb95–96	12.1%	6
Apr97–98	22.6%	1!!
Jan98–99	13.7%	5
Aug00–01	17.9%	3
Aug01–02	19.5%	2

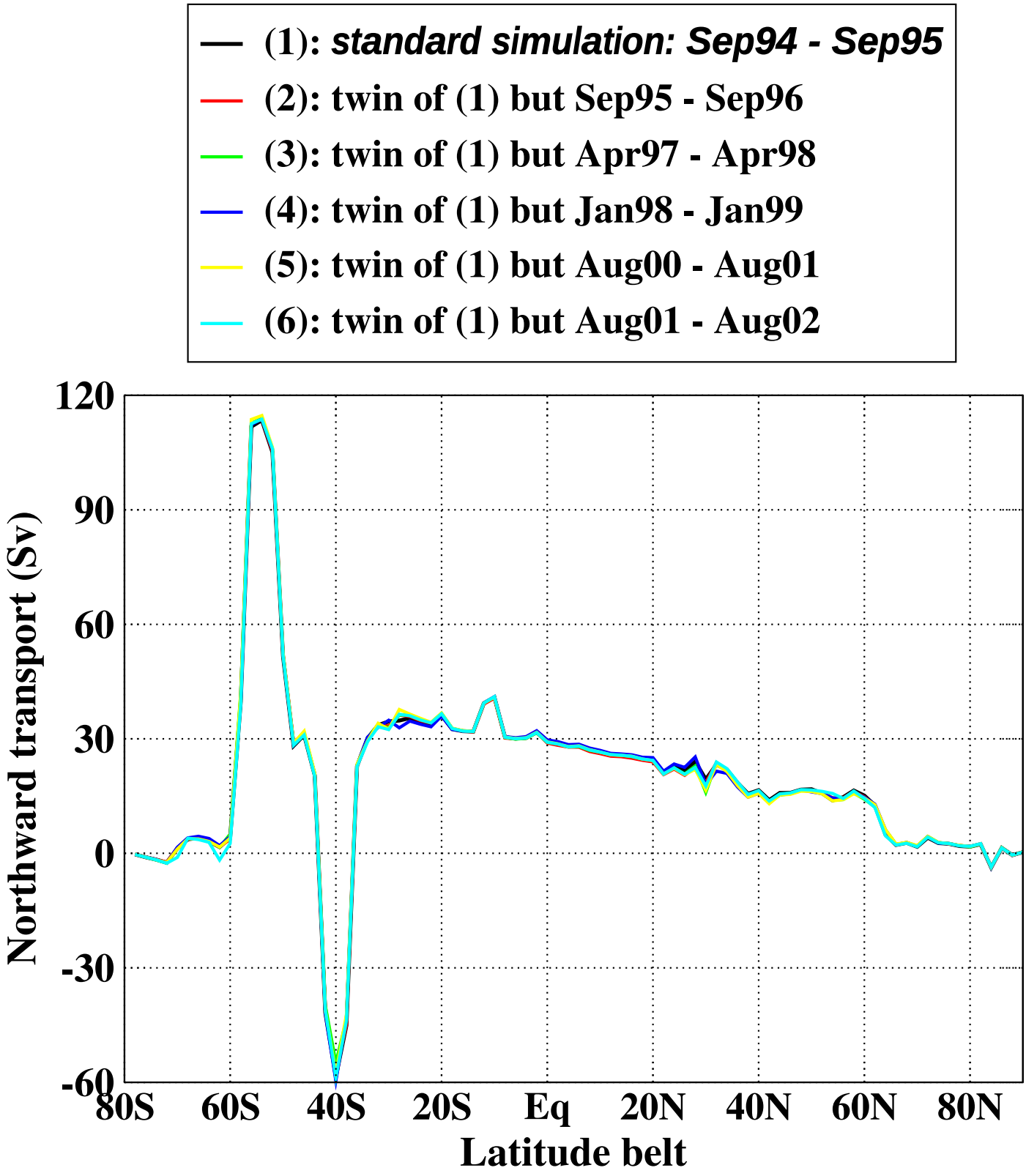
LOWEST RMS MIXED LAYER DEPTH DIFFERENCES



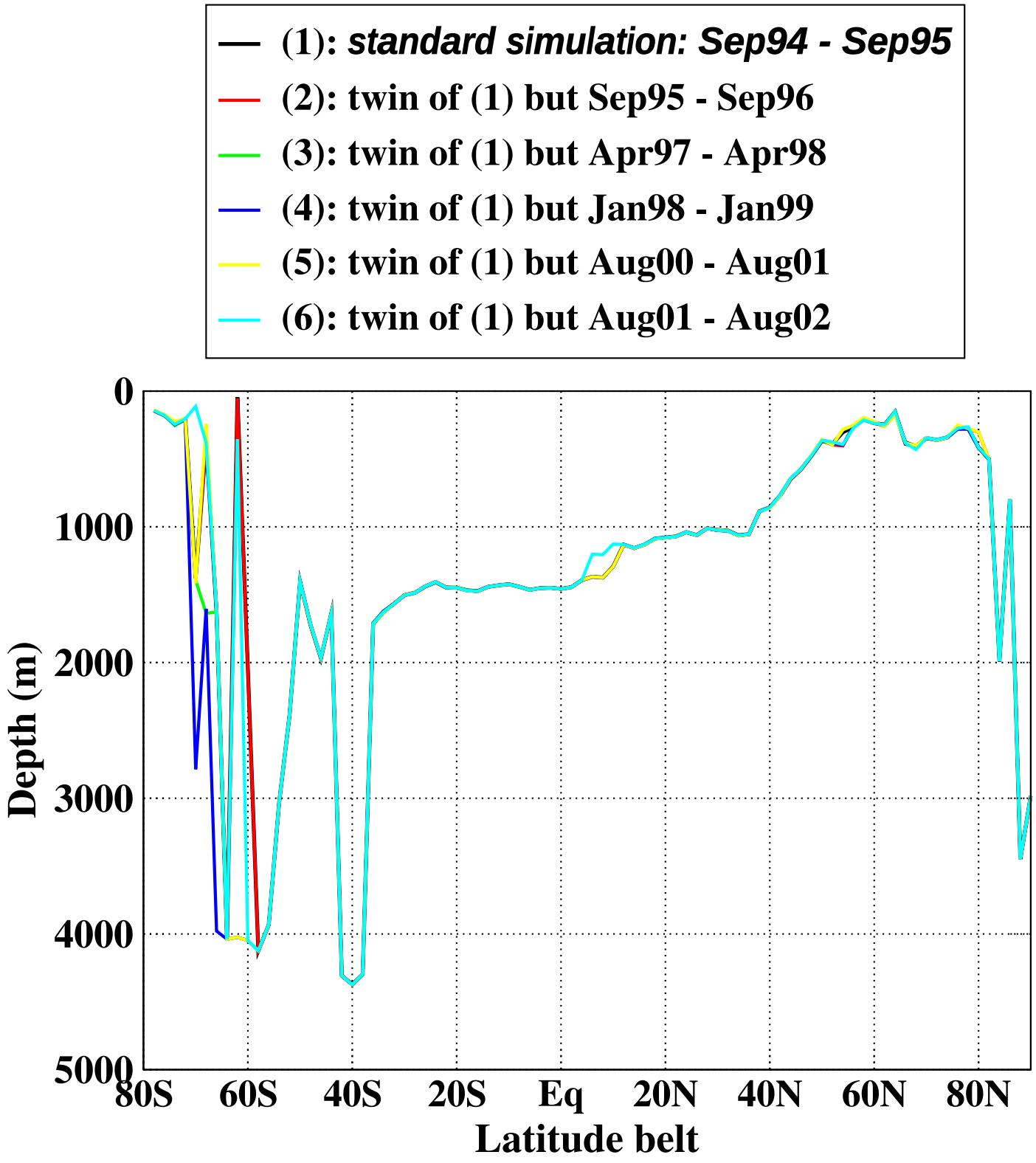
Percentage of global ocean coverage:

Anomaly	Percentage	Rank
Sep94–95	12.3%	6
Feb95–96	13.5%	5
Apr97–98	17.3%	4
Jan98–99	17.7%	3
Aug00–01	19.0%	2
Aug01–02	20.2%	1

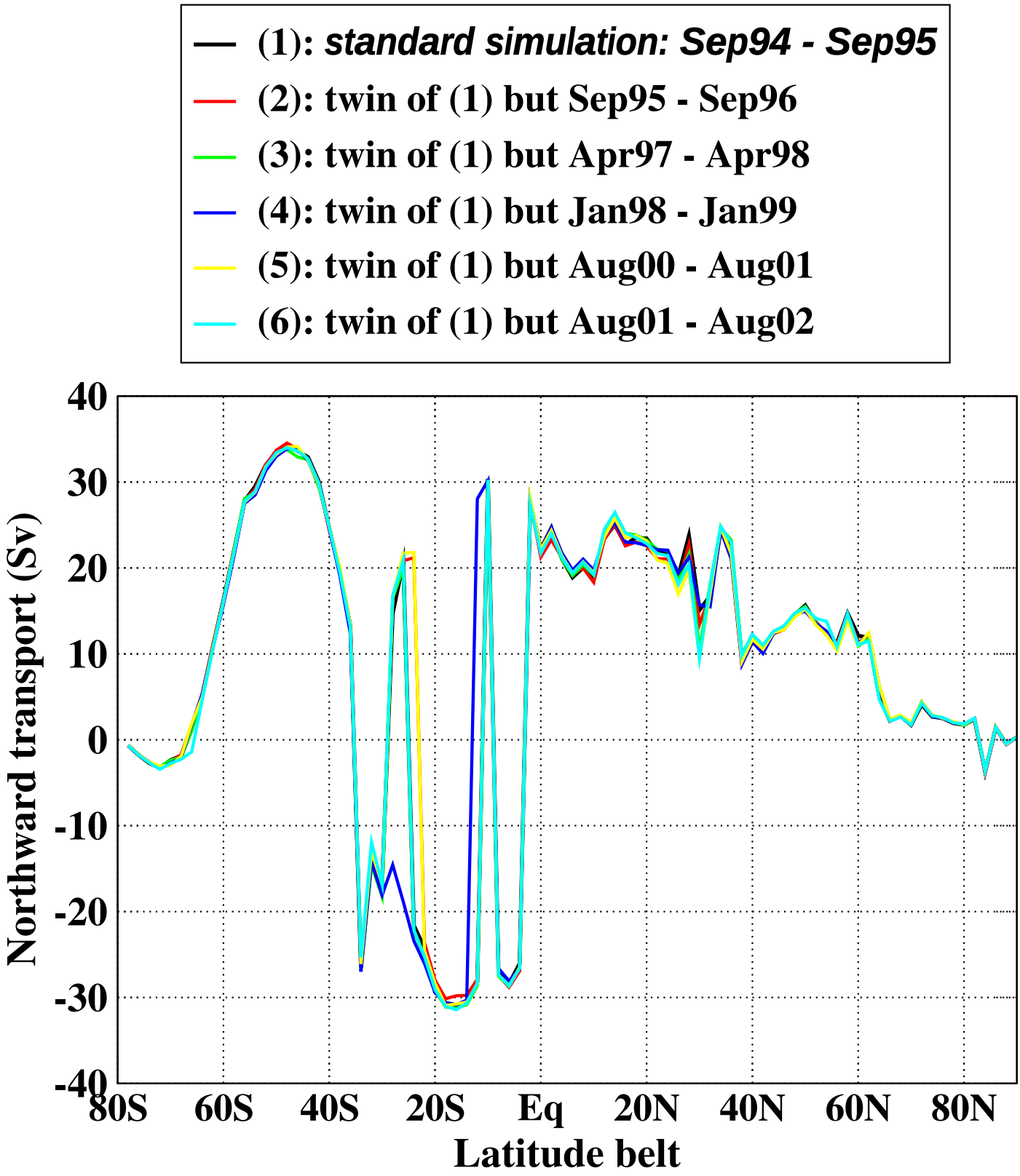
MAXIMUM OF ATLANTIC OVERTURNING



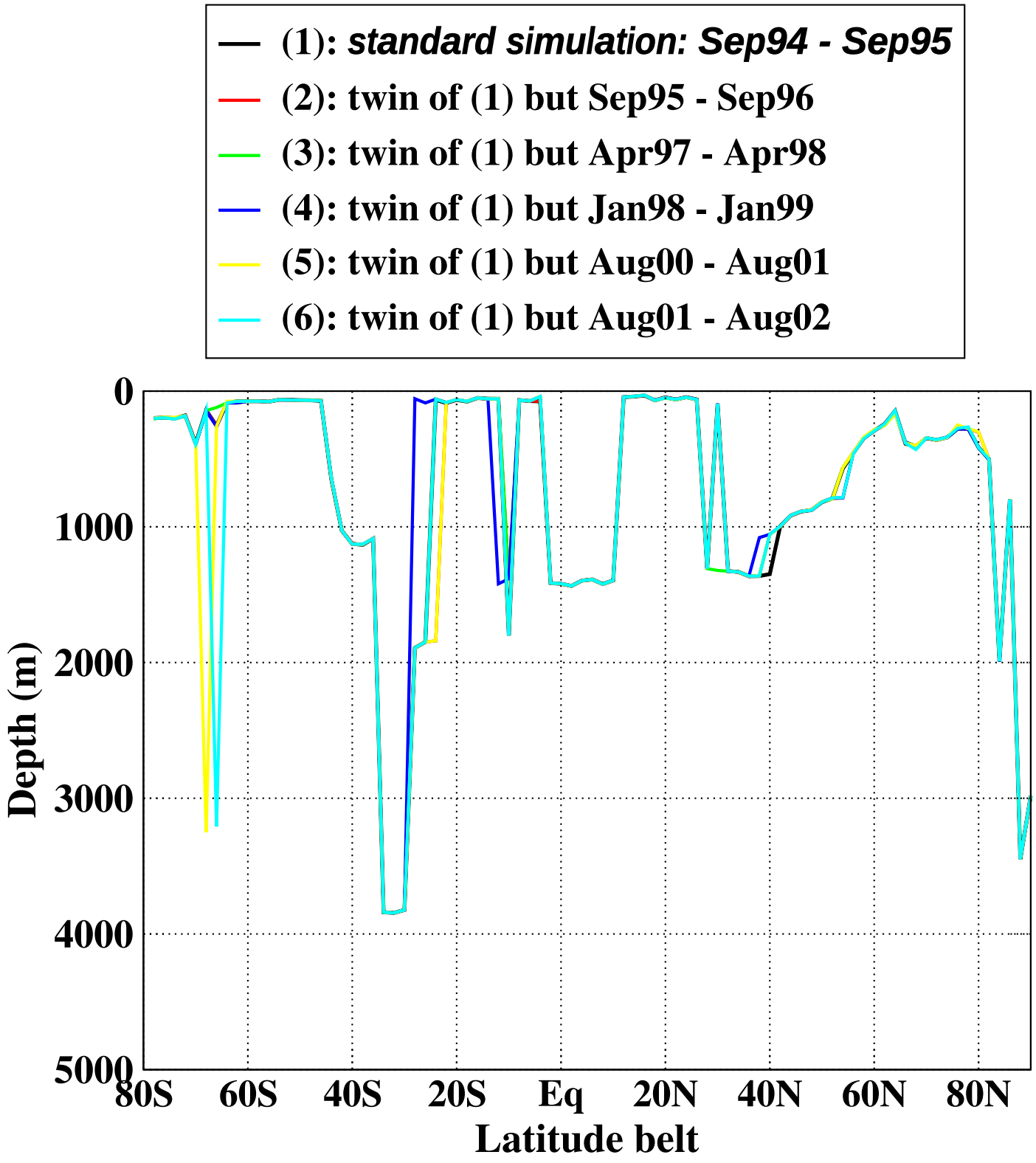
DEPTH OF MAX. OF ATLANTIC OVERTURNING



MAXIMUM OF GLOBAL OVERTURNING



DEPTH OF MAX. OF GLOBAL OVERTURNING



CONCLUSION

- Any anomaly time period can be used
- No significant change is noted in the HYCOM results
    - (1) climatological means of SST and MLD
    - (2) northward transport
    - (3) depth of overturning streamfunction

- However, we typically use snapshots for a daily output
- The period could be important for 3 hourly model analysis
- HYCOM now uses 6–hrly anomalies from NOGAPS in 2003